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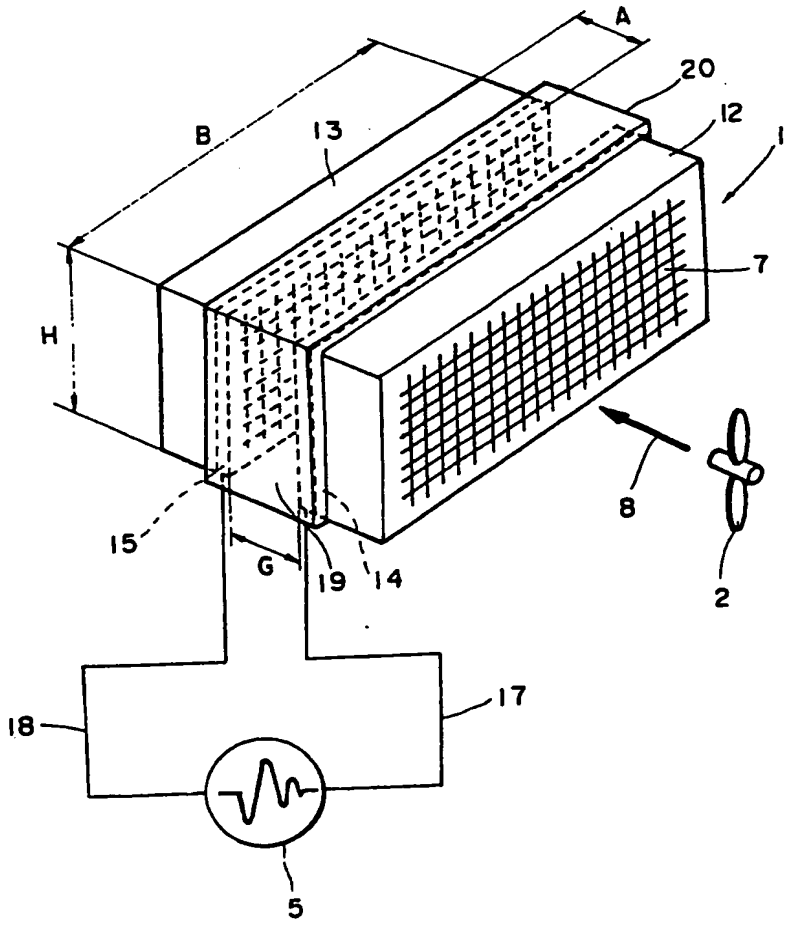
(54) Air sterilizing and deodorizing device

(57) An air deodorizing and sterilizing device (1) which is compact and safe to use comprises a plurality of catalyst members (12) each having throughholes (7) and disposed with gaps between each other, a cover (20) for tightly sealing the periphery of the gaps between each of the opposing surfaces of the adjacent catalyst members and electrodes (14, 15) disposed on the opposing surfaces of the catalyst members for applying a high voltage.

In a further modified device the catalyst members are made of material having electroconductivity substantially identical with that of the electrodes, so that a corona discharge is produced in the througholes of the catalyst members as well as between the electrodes. The deodorizing and sterilizing functions can be maintained for a long period of time.

FIG. 1



GB 2 229 365 A

FIG. 1

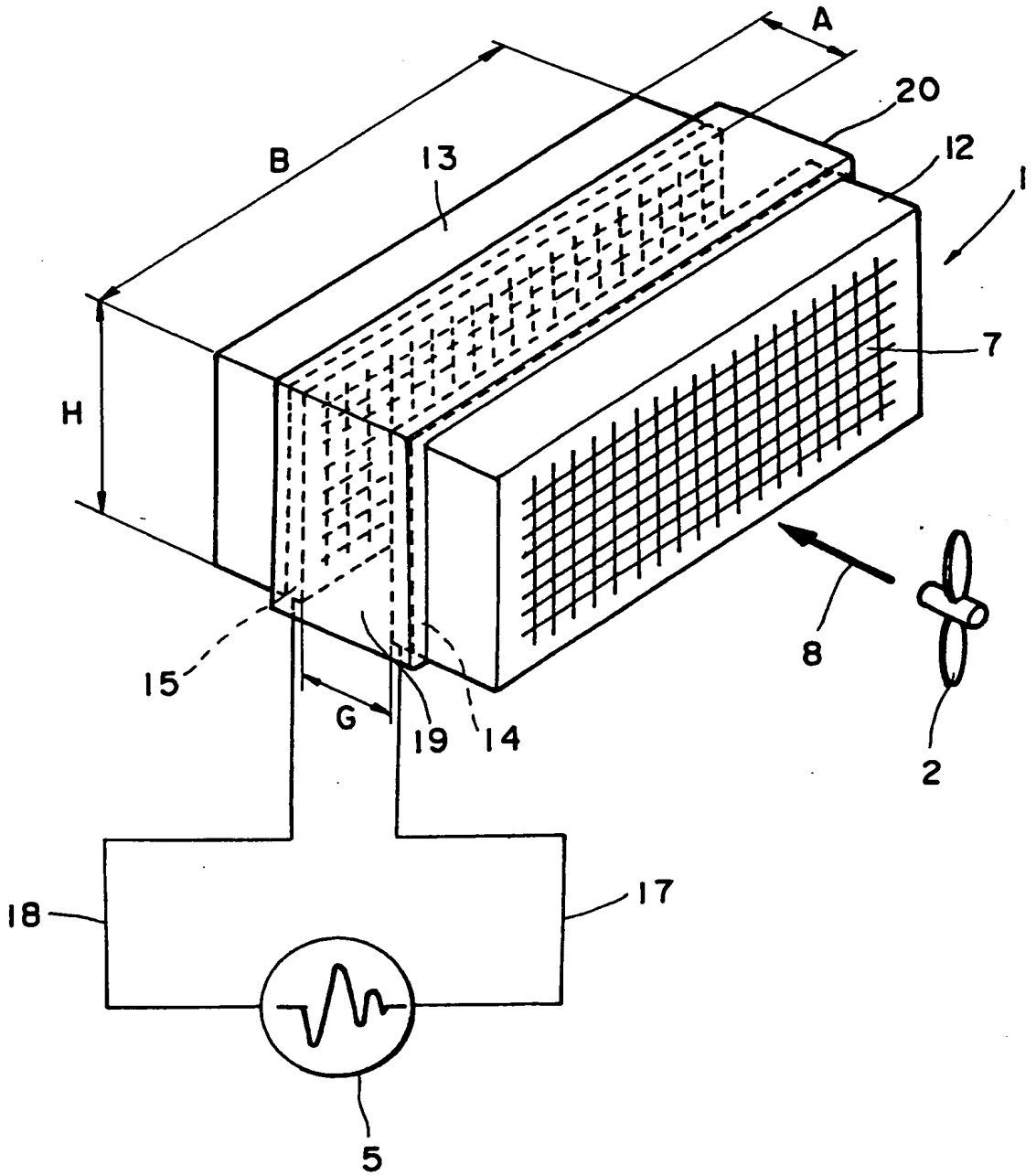


FIG. 2

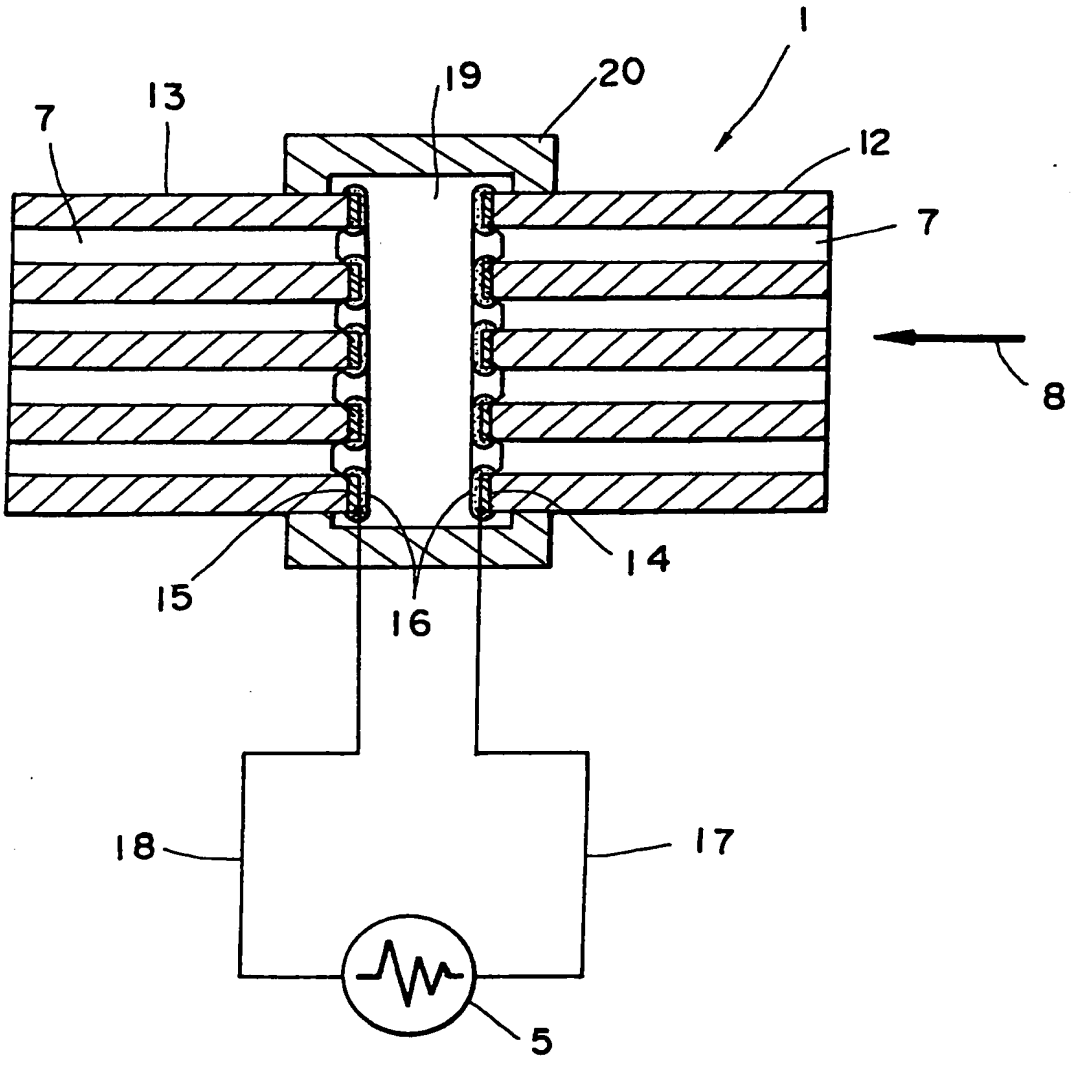


FIG. 3

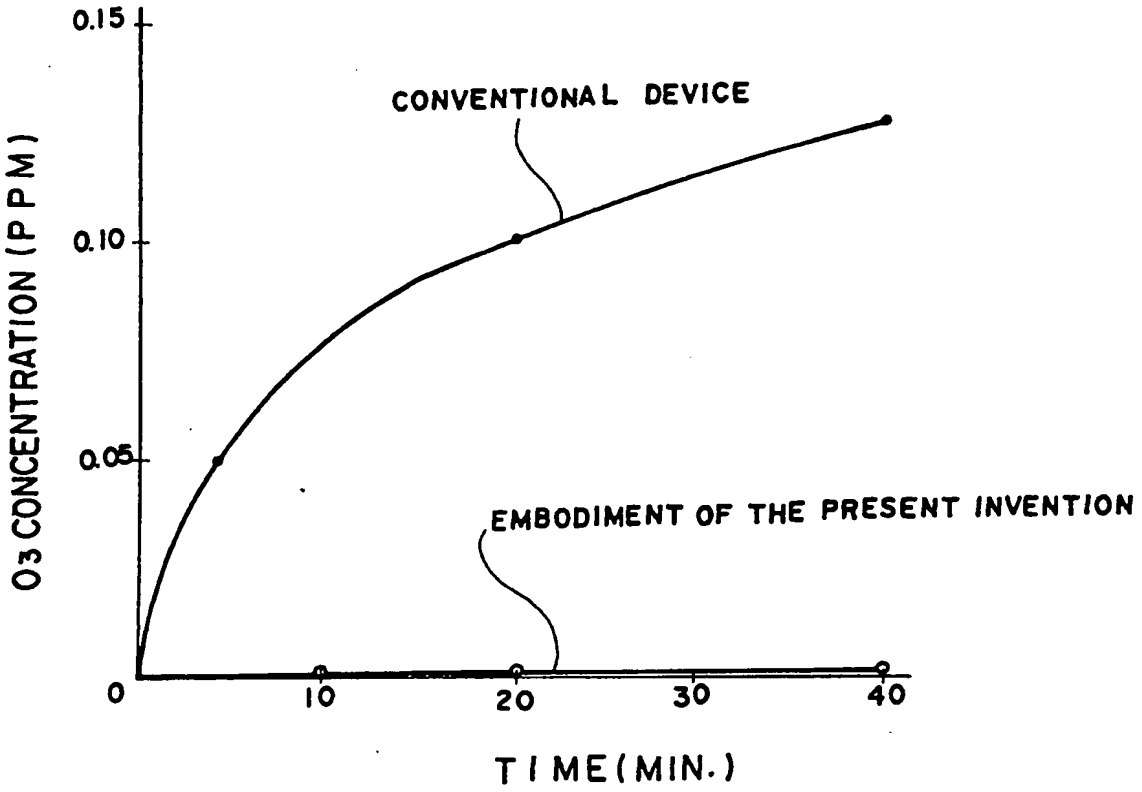

0.15
0.10
0.05
0
O3 CONCENTRATION (PPM)
CONVENTIONAL DEVICE
EMBODIMENT OF THE PRESENT INVENTION
10
20
30
40
TIME(MIN.)

FIG. 4(b)

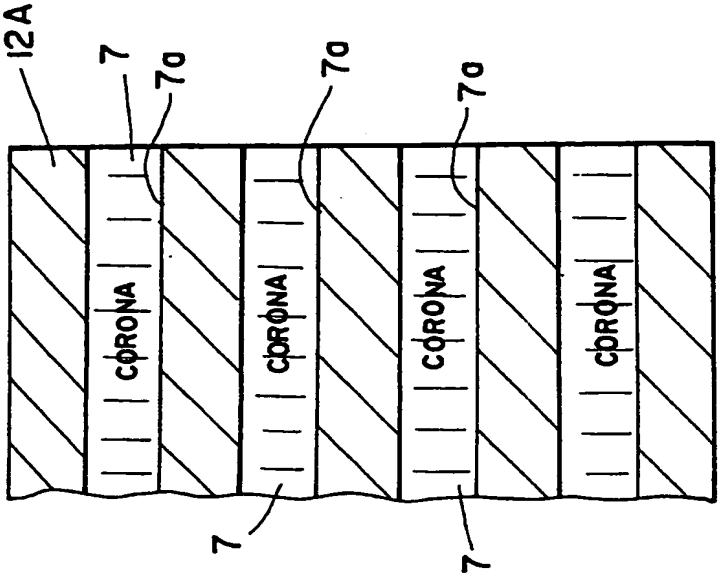

12A
7
7a
7a
7a
CORONA
CORONA
CORONA
CORONA
7
7

FIG. 4(a)

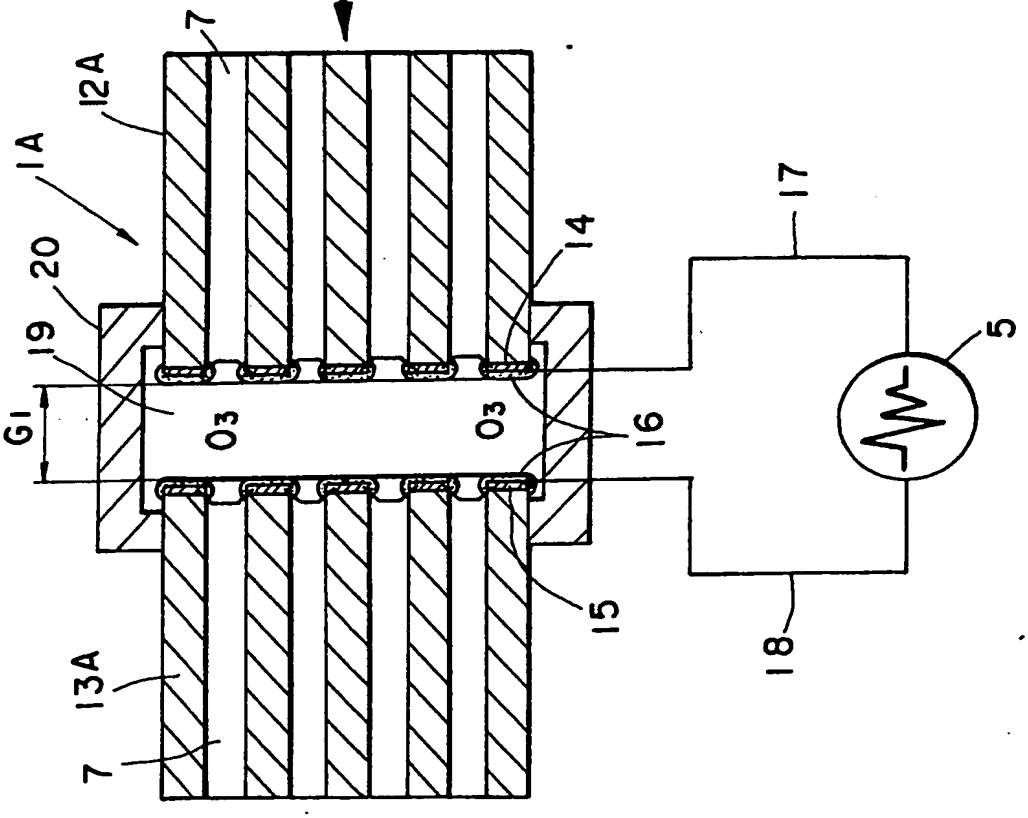

8
7
12A
1A
20
19
G1
O3
O3
14
16
17
5
15
18
13A
7

FIG. 5

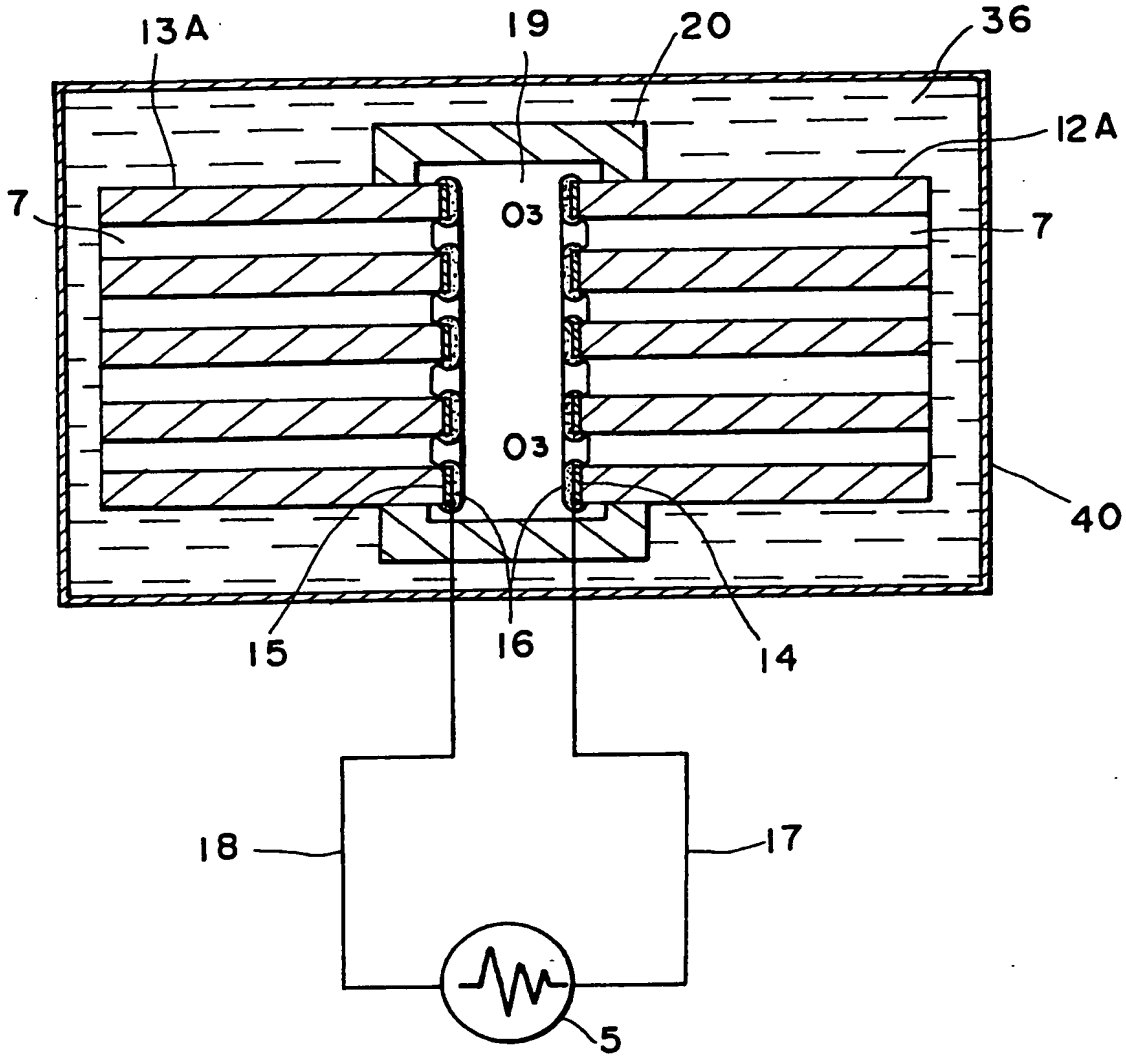


FIG. 6

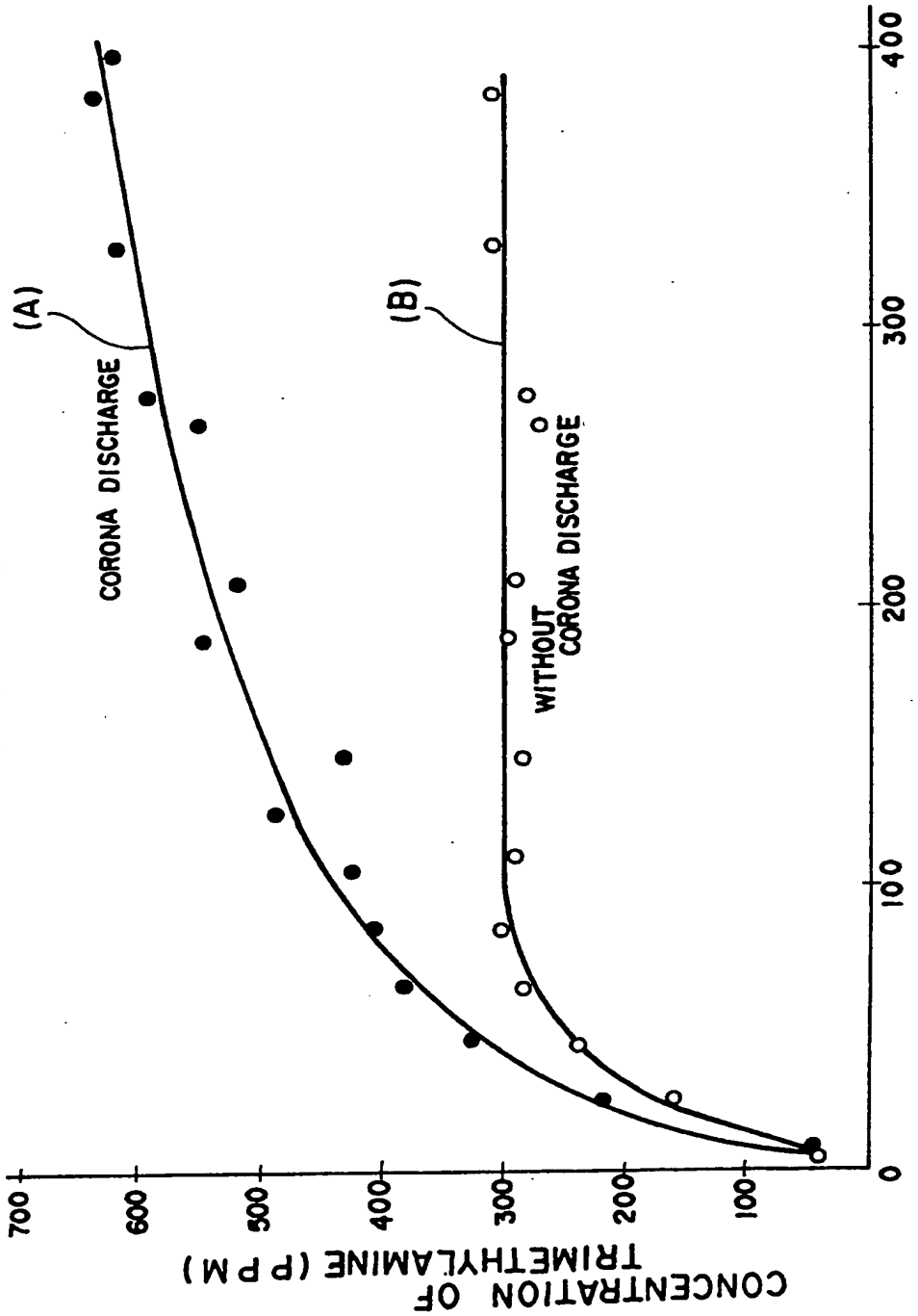

(A)
CORONA DISCHARGE
(B)
WITHOUT CORONA DISCHARGE
CONCENTRATION OF TRIMETHYLAMINE (PPM)
700
600
500
400
300
200
100
0
100
200
300
400
TIME (MIN.)

FIG. 7

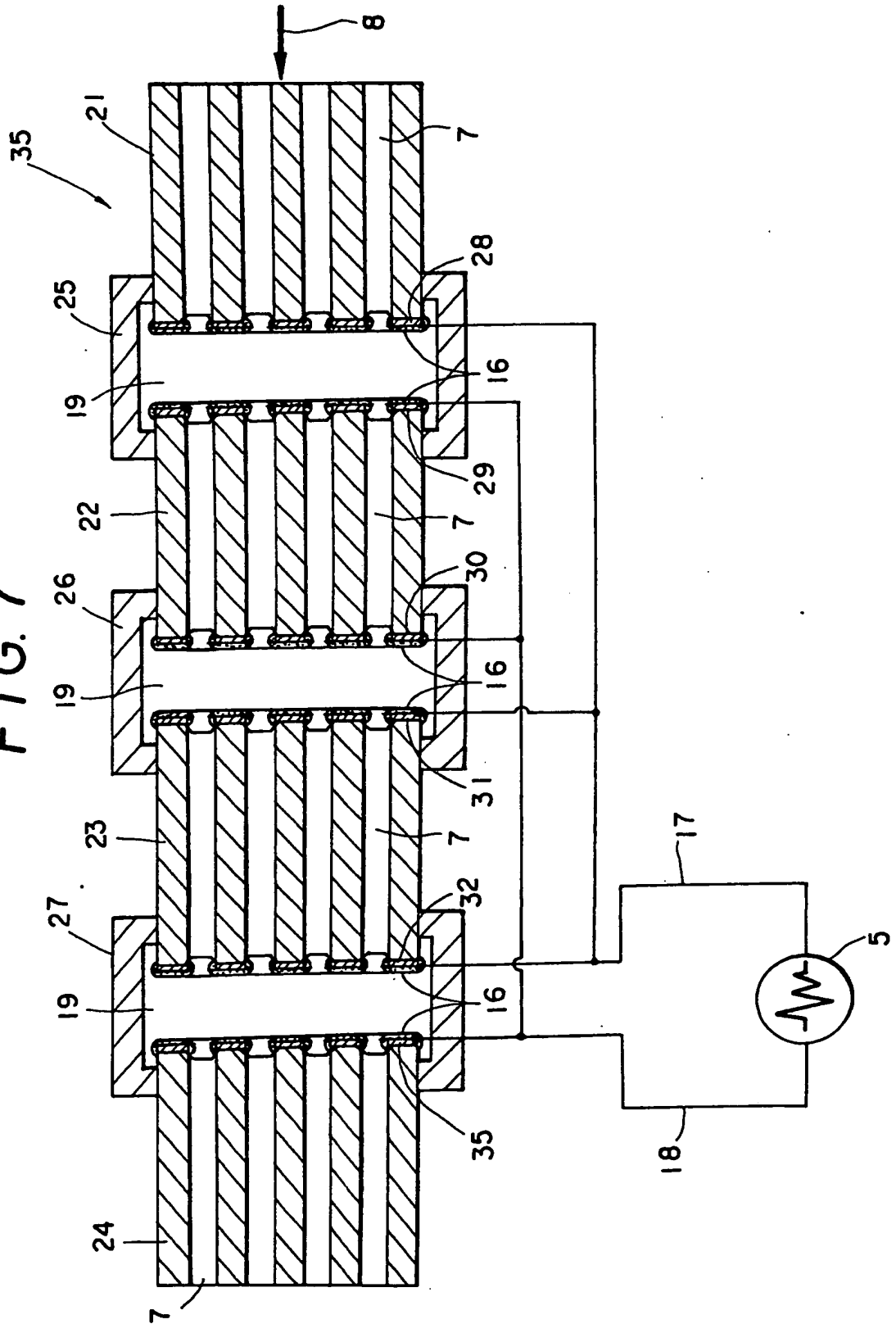

8
21
35
7
28
25
16
19
29
22
7
30
26
16
19
31
23
7
17
32
27
5
16
19
35
18
24
7

FIG. 9

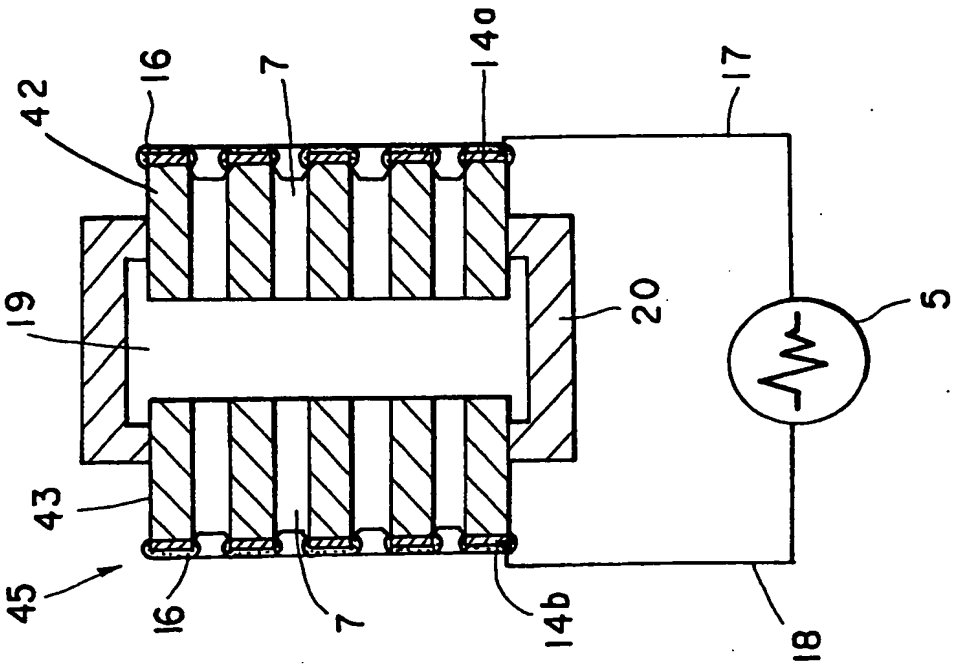


FIG. 8

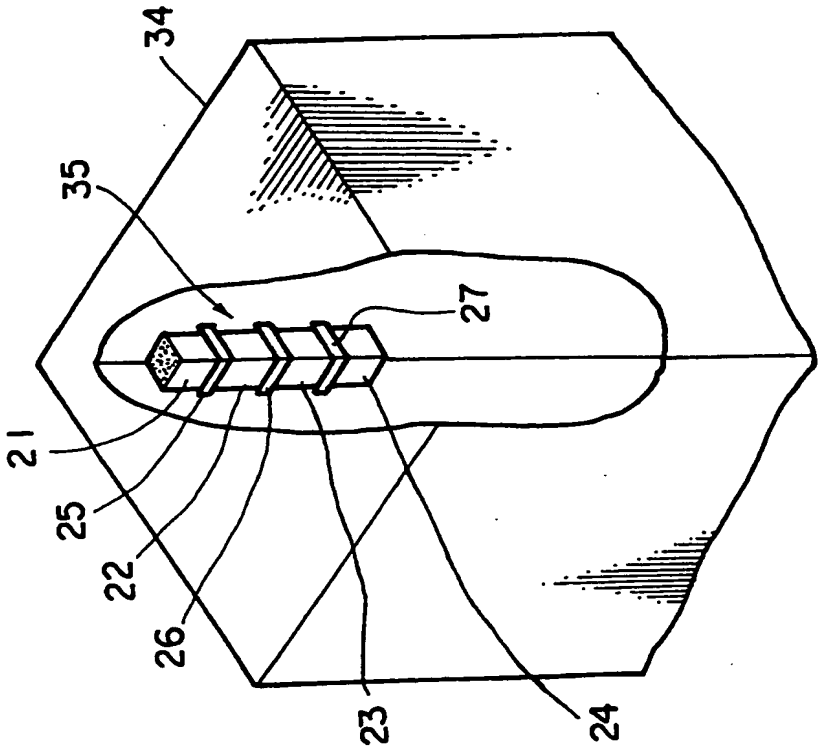
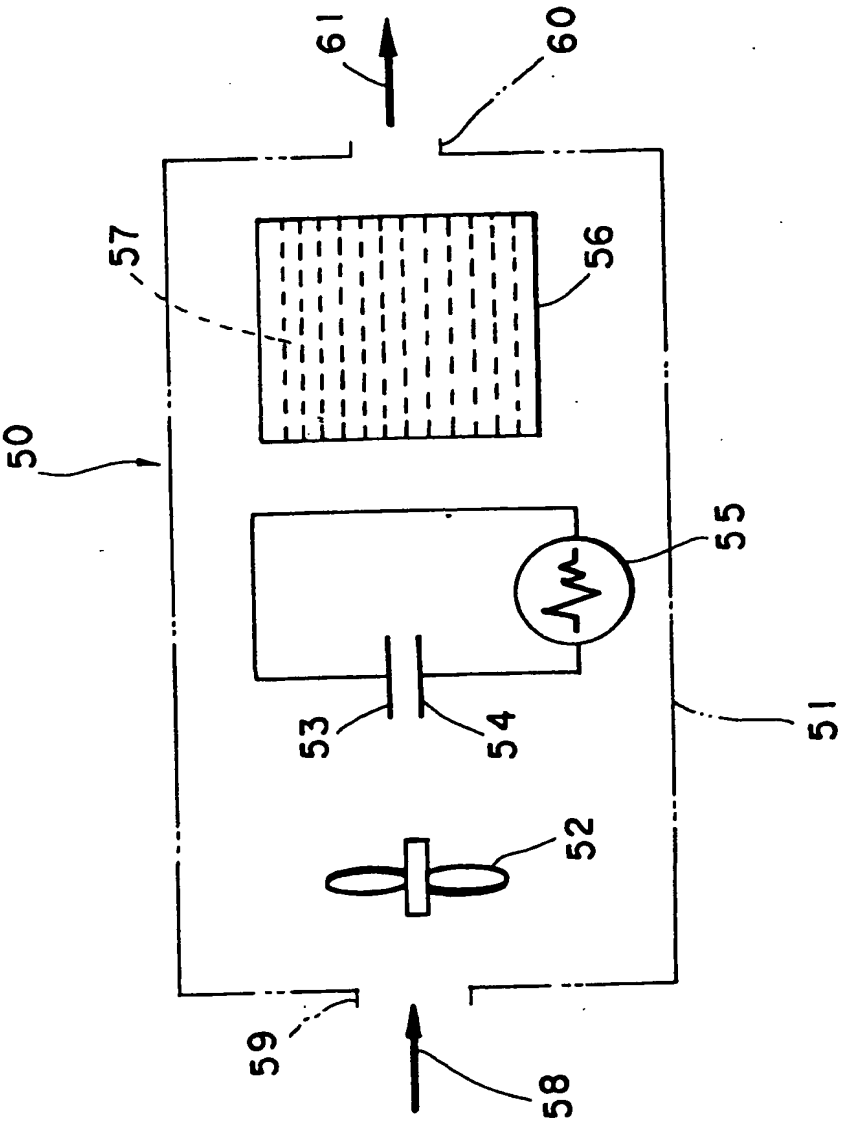


FIG.10



STERILIZING AND DEODORIZING DEVICE

The present invention concerns a sterilizing and deodorizing device for removing odors, for example, in a refrigerator, etc. or in a room and, at the same time, sterilizing bacteria suspending in atmospheric air. More particularly, it relates to a device for generating ozone by the application of a high voltage, reacting generated ozone with smelly components causing odors, to conduct deodorization and sterilization and, further, killing odors by a catalyst and decomposing excess ozone by the catalyst so that generated ozone is not leaked to the outside.

A conventional sterilizing and deodorizing device 50 has been constituted as shown in Fig.10. In Fig. 10, there are shown a casing 51, a blower 52, ozone generating electrodes 53, 54 supplied with high voltage from a high voltage power source 55, and a catalyst 56 having a plurality of through holes 57 in a honeycomb-like shape. The catalyst is made by entirely sintering material having deodorizing and ozone decomposing catalytic activity or disposing a catalyst on the inner surface of the through holes 57. In this sterilizing and deodorizing device 50, a high voltage is applied

between the electrodes 53 and 54 from the high voltage power source 55 to induce corona discharge and generate ozone. Then, smelly components in air 58 introduced by the blower 52 from an inlet 59 to the inside of the casing 51 are reacted with ozone to be deodorized, and sterilized. Then, the air is passed through the through holes 57 in the catalyst member 56, so that it is further deodorized and excess ozone is decomposed to discharge air 61 with reduced smelly components and free from ozone from the exit 60. Excess ozone is decomposed in the catalyst member 56, because ozone is harmful to a human body such, if present in a great amount, possibly attacking lungs, causing dazzling, giving stimulations to eyes, etc.

However, in the conventional device 50 as described above, if the operation of the blower 52 is interrupted by means of troubles or wire disconnections, since ozone generated between the electrodes 53 and 54 does not flow into the through holes 57, it is not decomposed but may diffuse through the inlet 59 or the exit 60 to the outside of the casing 51 to bring about a safety problem.

Further, since an ozone generation device comprising the electrodes 53, 54 and the high voltage power voltage 55, and the catalyst member 56 are disposed separately, a large installation space is required, which is not suitable to those devices of narrow space such as a refrigerator, etc.

In addition, in the conventional device 50 as described above, the ozone generating electrodes 53 and 54 for generating ozone and the catalyst member 56 for deodorizing ozone decomposing effects are disposed separately. Further, since the catalyst member 56 has a high surface activity and sensible to contaminations with moistures or oils, as well as dusts such as tobacco smokes. Then, if the surface of the catalyst member 56 is covered with contaminations, it results in the problem that the deodorizing or decomposing efficiency is reduced to leave odors or harmful excess ozone as it is. In such a case, there is no effective means for reactivating the catalyst member 56 in the conventional device 50 and the catalyst member 56 has to be replaced with fresh one on every contamination.

In view of the foregoing problems in the prior art, it is an object of the present invention to provide a compact sterilizing and deodorizing device of improved safety.

Another object of the present invention is to provide a deodorizing device capable of maintaining of deodorizing effect and decomposing effect of ozone for a long period of time.

The sterilizing and deodorizing device according to

the present invention comprises a plurality of honeycomb-shape catalyst members each having a plurality of through holes and connected in cascade at a predetermined gap to each other, a cover member for tightly sealing the periphery of gaps between opposing surfaces of adjacent catalyst members and electrodes disposed for applying a high voltage is applied between the opposing surfaces.

In the present invention with the foregoing constitution, air to be treated is at first deodorized when it is passed through the through holes of the first catalyst member. Then, corona discharge is induced by a high voltage applied between the electrodes disposed between the opposing surfaces of the catalyst members to generate ozone, by which the air passed through the through holes of the first catalyst member is sterilized and deodorized. Further, odors are removed and excess ozone is decomposed by the catalyst in the through holes of the downstream catalyst members.

In a case where the device comprises three or more catalyst members, such operation and processing are repeated in the same way.

The device according to the present invention is applicable both to a constitution in which air is caused to flow into the through holes in the catalyst member by utilizing spontaneous convection, and a constitution

having a blower. Even in a case if the air stream should be interrupted due to troubles of a blower, etc. and ozone is generated continuously between the electrodes, since ozone is decomposed between the catalyst members on both sides, ozone can be prevented from external discharging.

In a further embodiment, the present invention provides a deodorizing and sterilizing device which comprises a plurality of honeycomb-shape catalyst members each having a plurality of through holes and connected in cascade at a predetermined gap to each other, a cover member for tightly sealing the periphery of gaps between opposing surfaces of adjacent catalyst members and electrodes disposed for applying a high voltage is applied between the opposing surfaces and used for deodorization and sterilization, in which each of the catalyst members is made of material having comparable electroconductivity substantially identical with that of the electrode, so that corona is discharged between the through holes of the catalyst member as well as between the electrodes.

With the device according to the present invention having the foregoing constitution, ozone is generated between the electrodes disposed to each of the catalyst members and used for deodorization and sterilization and, since corona is discharged also between the through holes of the catalyst member and electrons and ions formed by

the corona discharge impinge against the surface along the through holes of the catalyst member, contaminations deposited on the surface are repelled.

For a better understanding of the present invention and to show how the same may be carried into effect, reference will now be made by way of example, to the accompanying drawings in which:-

Fig. 1 is a perspective view illustrating a preferred embodiment of a sterilizing and deodorizing device according to the present invention;

Fig. 2 is a cross sectional view of the device shown in Fig. 1;

Fig. 3 is a graph illustrating the change of the amount of ozone leaked upon stopping of a blower in the conventional device and the device according to the present invention;

Fig. 4(a) is a cross sectional view of another embodiment of the device according to the present invention; and

Fig. 4(b) is an explanatory view for the operation of the device;

Fig. 5 is a cross sectional view illustrating the state of testing the effect of the preferred embodiment,

Fig. 6 is a graph illustrating the result of the test;

Fig. 7 is a cross sectional view showing a further embodiment of the device according to the present invention;

Fig. 8 is a perspective view illustrating a state of

mounting the device;

Fig. 9 is a cross sectional view of a still further embodiment of the device according to the present invention; and

Fig. 10 is a cross sectional view of a conventional device.

The preferred embodiments of the present invention will be described by reference to Figs. 1 to 3.

Example 1

Fig. 1 and Fig. 2 are, respectively, a perspective view and a cross sectional view for one embodiment of a sterilizing and deodorizing device 1 according to the present invention. In the figures, catalyst members 12, 13 each having a plurality of through holes 7 are prepared, as described above, from material having a catalytic effect by means of sintering, etc. or depositing a catalyst to the inner surface of the through holes 7 by means of flame spraying or coating. The catalyst usable herein may comprise SiO_2 as the main ingredient mixed with MnO_2 or TiO_2, or insulating material such as activated carbon, but the catalyst used in the present invention is not limited only thereto.

The catalyst members 12 and 13 are disposed at an appropriate gap G and electrodes 14, 15 made of copper alloy, silver or aluminum are integrally formed to the opposing surfaces of both of the members by means of flame spraying, and the electrode surface is coated with insulation material 16 such as a resin or varnish. The respective electrodes 14 and 15 are connected by way of wires 17 and 18 to the output terminal of the high voltage power source 5 respectively. A cover 20 is attached to abutting ends of the catalyst members 12, 13 so that the periphery around the gap 19 between the catalyst members 12 and 13 is tightly closed. The cover 20 is a cylindrical form made of insulating material such as a resin and, if required, secured at the both ends of the cover 20 to the catalyst members 12 and 13 by means of adhesives. In this embodiment, the catalyst (12 or 13) has length A of 13 mm, width B of 60 mm and height H of 30 mm. Further, the gap 19 (G) is 1 mm - 10 mm and the through hole 7 has about 0.5 mm to 1.0 mm of diameter (in the case of a circular hole) or orthogonal diameter (in the case of a polygonal hole), but the invention is not restricted to such a size for each of the portions.

In this constitution, air 8 to be treated is introduced by the blower 2 into the through holes 7 of the catalyst member 12 and deodorized upon passing through

the through holes 7 due to the contact of the smelly components with the catalyst. On the other hand, corona is discharged due to a high voltage applied between the electrodes 14 and 15 from the high power voltage power source 5 to generate ozone, which sterilizes and deodorizes the air 8 as it passes through the through holes 7 of the catalyst member 12. Further, the air is deodorized and excess ozone is decomposed by the catalyst in the through holes 7 is the adjacent catalyst member 13 through which the air is passed subsequent.

Fig. 3 shows a change of ozone concentration with lapse of time at the outside of a casing when the conventional device 50 as shown in Fig. 10 or the embodiment 1 of the present invention is placed in a test chamber and ozone is continuously generated by the high voltage power source 5 after interrupting the operation of the blower 2 (casing is not shown in Figs. 1 and 2). In the conventional device 50, the ozone concentration is gradually increased. On the other hand, in the case of the device 1 according to the present invention, the ozone concentration shows no substantial increase and leakage of ozone was not observed even after elapse of 40 min. Accordingly, if the operation of the blower 2 should be interrupted by some or other reasons, ozone leakage is not caused. Further, in the device 1 according to the present embodiment, air can be

caused to flow through the through hole 7 also by utilizing a spontaneous convection formed at the inside of a refrigerating chamber, etc. Also in this case, if the direction of the air stream is reversed by some or other reason, ozone does not leak to ensure a safety state. Accordingly, a sterilizing and deodorizing device not requiring the blower 2 can be realized and, for example, a cell-actuated device is provided.

In the deodorizing and sterilizing device 1 as detailed above, since the ozone generation section is in communication with the outside of the sterilizing and deodorizing section only by way of the through holes in the catalyst member, if the stream of air to be treated is eliminated due to interruption of the blower, etc. generated ozone is always passed through the through holes in the catalyst member and decomposed. Accordingly, leakage of ozone to the outside of the sterilizing and deodorizing region can be prevented to improve the safety. Further, since the electrodes are combined with the catalyst member, etc. a compact sterilizing and deodorizing device can be obtained.

Description is to be made for another embodiment of the present invention referring to Figs. 4 to 6.

In a deodorizing and sterilizing device 1A shown in Fig. 4(a), components having identical functions with

those in the device 1 shown in Figs. 1 and 2 carry the same reference numerals and detailed descriptions therefor are omitted.

Example 2

The deodorizing and sterilizing device 1A shown in Fig. 4(a) comprises honeycomb-shaped catalyst members 12A and 13A each having a plurality of through holes 7 as in the device 1 described above.

The catalyst members 12A, 13A are made of material having substantially identical electroconductivity with that of electrodes 14 and 15 (electric resistance between both end faces of about 4 to 30 K·Ω, preferably, less than 5 KΩ.

The catalyst members 12A, 13A usable herein are made of, for example, electroconductive material such as metal powder mixed with SiO_2, MnO_2 and TiO_2, or with activated carbon, or honeycomb-like electroconductive support coated with TiO_2, MnO_2, etc.

Electrodes 14, 15 made of copper alloy, silver or aluminum are integrally formed by means of flame spraying, etc. to the opposing surfaces of the catalyst members 12A, 13A at such an arrangement as forming a gap 19 (G_1 = about 2 mm) and insulation material 16 such as made of a resin or ceramic is coated to the surface of both of the electrodes 14 and 15.

As a constitutions of the device 1A are the same as those in the device 1 shown in Figs. 1 and 2.

Description will then be made to the operation of the device 1 having the foregoing constitution while also referring to Fig. 4(b), Fig. 5 and Fig. 6.

Air 8 to be treated is introduced by means of the blower 2 into the through holes 7 of the catalyst member 12A and the smelly components are deodorized upon passing through the through holes 7 being in contact with the catalyst. On the other hand, corona is discharged due to the high voltage applied between the electrodes 14 and 15 from the high voltage power source 5 to generate ozone. The air 8 passed through the through holes 7 in the catalyst member 12A is sterilized and deodorized by ozone. Further, air is deodorized and excess ozone is decomposed by the catalyst in the through holes 7 of the catalyst member 13 disposed at the downstream.

In addition to the generation of ozone by the electrodes 14 and 15 as described above, corona is discharged also on the surface 7a facing the through holes 7 of the catalyst member 12A as shown in an enlarged view of Fig. 4(a). Streams of electron or ion, caused by the corona discharge repel contaminants such as moistures or oils deposited to the surface 7a. The repelled contaminants are carried on the stream of air 8 and discharged to the

outside of the device 1. The situation is quite the same also in the catalyst member 13A.

Fig. 5 shows a test device for testing the effect of removing contaminants in the deodorizing device 1, while Fig. 6 is a graph illustrating the result of the test.

In the test device shown in Fig. 5, an aqueous 30% solution of trimethylamine 36 and, the catalyst members 12A, 13A attached with the electrodes 14, 15 and the cover 20 of the deodorizing device 1A are placed in a box-like tightly sealed vessel 40, and the catalyst members 12A, 13A are impregnated with the 30% aqueous solution of trimethylamine 36. After drying in air, a high voltage with a peak value of 9 to 10 (KV) is applied to the electrodes 14 and 15 from the high voltage power source 5.

A test result in a case of applying the high voltage is shown as the characteristics (A) represented by full circles, while a test result in a case of not applying the high voltage is shown as the characteristic (B) represented by blank circles in Fig. 6 respectively.

In Fig. 6, the abscissa shows time T (min) while the ordinate shows the value for the concentration of trimethylamine 36 in the tightly sealed vessel 40 as measured by gas chromatography.

As apparent from Fig. 6, the concentration is settled to a constant value of 300 ppm after elapse of 100 (min),

since dissociation of trimethylamine adsorbed and re-adsorption thereof are equilibrated.

On the other hand, the characteristic (A), for the state in which corona discharge occurs by the application of the high voltage shows a tendency that the concentration measured for trimethylamine gradually increases with elapse of time T.

This is due to the fact that the amount of trimethylamine driven out by electric discharge from the surface of the catalyst is greater than the adsorbed amount showing that the effect of removing trimethylamine adsorbed to the surface 7a facing the through holes 7 of the catalyst members 12A, 13A is remarkable.

In the deodorizing and sterilizing device 1A as described above specifically, it is possible to attain a deodorizing effect for the smelly components due to the generation of ozone and decomposing effect of excess ozone and to induce corona discharge also in the through holes of the catalyst member due to the improvement for the material of the catalyst member. It is, accordingly, possible to provide a deodorizing and sterilizing device having an excellent effects for removing contaminants and capable of maintaining the foregoing effects over a long period of time.

Example 3

A further embodiment of the present invention will be

explained next referring to Fig. 7.

In a deodorizing and sterilizing device 35 shown in Fig. 7, catalyst members 21 through 24 each having a plurality of through holes 7 in the same constitution as that of the catalyst members 12, 13 are connected in cascade with each other by means of tightly sealing covers 25 through 27 each at a predetermined gap, and electrodes 28 through 33 for applying a high voltage from a high voltage power source 5 are disposed to the opposing surfaces of each of the catalyst members 21 through 24 respectively.

Also in the deodorizing and sterilizing device 35, the same function and effect as those in the sterilizing and deodorizing device 1 can be provided. In addition, the cross sectional area for each of the catalyst members 21 through 24 can be reduced and the deodorizing device 35 can be mounted, for example, at a corner of a refrigerator 34, etc. without trouble as shown in Fig. 8. In the case of a vertical type as shown in Fig. 8, an air stream by spontaneous convection can be utilized but the device may be disposed horizontally with a blower being disposed.

Example 4

Fig. 9 shows a still further embodiment of the present invention. In the deodorizing device 45 shown in Fig. 9, catalyst members 42, 43 reduced in the size both in the length and the width are disposed opposed to each other

instead of the catalyst members 12, 13 of the deodorizing device 1, and electrodes 14a, 14b are disposed to the outer end faces of the catalyst members 42, 43 respectively. Also with the deodorizing device 45, the same effect and function as those in the deodorizing device 1 described above can be obtained and the entire size is reduced to save the installing space.

The invention is not restricted only to the foregoing embodiments but various modifications are possible within the scope of the invention.

In the foregoing embodiments, electrodes are disposed integrally to the catalyst members, but the electrodes are not necessarily integrated to the catalyst member. Further, the electrode can be attached not to the end face of the catalyst member but to the cover.

CLAIMS:

1. A deodorizing and sterilizing device comprising a plurality of honeycomb shape catalyst members each having a plurality of through holes and disposed in cascade at a gap with each other, a cover for tightly sealing the periphery of the gap between each of the opposing surfaces of the adjacent catalyst members, and electrodes disposed between the opposing surfaces of said catalyst members for applying a high voltage.

2. A deodorizing and sterilizing device comprising a plurality of catalyst members each having a plurality of through holes, equipped with electrodes and disposed at a gap to each other and a cover for tightly sealing the periphery between the opposed surfaces of the adjacent catalyst members in which a high voltage is applied to each of said electrodes and generate ozone by corona discharge between each of said electrodes for deodorization, wherein each of said catalyst members is made of material having electroconductivity substantially identical with that of said electrodes, so that corona discharge is formed between the opposing inner walls of the through holes in the catalyst members as well as between the electrodes.

3. A deodorizing and sterilizing device as defined in claim 2, wherein the electrodes are disposed to the opposing surfaces of the catalyst members covered with said cover.

4. A deodorizing and sterilizing device as defined in claim 2, wherein the electrodes are disposed to the outer ends of each of said catalyst members.

5. A deodorizing and sterilizing device substantially as hereinbefore described with reference to or as shown in the accompanying drawings.

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